A Treatise on Perpetual Motion of Second Kind

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U N I S T A R

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“Remembering that I’ll be dead soon is the most important tool I’ve ever encountered to help me make the big choices in life. Because almost everything –all external expectations, all pride, all fear of embarrassment or failure-these things just fall away in the face of death, leaving only what is truly important.

Remembering that you are going to die is the best way I know to avoid the trap of thinking you have something to lose. You are already naked. There is no reason not to follow your heart.”

“Your time is limited, so don’t waste it living someone else’s life. Don’t be trapped by dogma-which is living with the results of other people’s thinking. Don’t let the noise of others’ opinions drown out your own inner voice.”

Steve Jobs at the Stanford convocation lecture in 2005

Preface

Oft repeated unsuccessful efforts to attain the perpetual motion since middle ages did nothing except strengthening the laws of thermodynamics. In ninetieth century perpetual motion was announced a pseudo science by the scientists of that time. Law of conservation of energy and second law were established in the end of this century but the pursuit of perpetual motion continued and at present if someone comes up with the idea of free energy it is taken by the physicists as a hoax. We can find a lot of such proposals of free energy on the internet and lot of designs based on the same principles as ancient perpetuum were based only with the exception of their names. Vacuum energy is very popular among these inventors. One can be surprised by a bizarre claim of a machine that gives more output than the input by converting some amount of mass of copper wires into energy. Many investors lost their money for such kind of lucrative but hollow business proposals.

These inventors are not clear themselves how their machines work or what is the principle on the basis of which they should work and it seems very absurd when the science is so much developed and every new theory has to go through the great minds before becoming the part of existing knowledge.

Perpetual motion simply violates the known laws of physics. These laws have become a common sense for present scientific community. American physicist Michio Kaku considers the perpetual motion as third type of impossibility because it is not possible according to present understanding of physical laws.

In order to consider in most general way the production of perpetual motion, it is important that it must be considered with extraordinary proves. A working prototype of a machine producing such unlimited power can be a most extraordinary proof but so far no such a device satisfied even a science graduate. Therefore the proof provided should be consistent with the existing laws of physics or they should be extended and generalized enough in order to achieve that fantasy. That is why I think that a satisfying theory is required for perpetual motion that is capable of being tested by the experts standing at the front of knowledge. But it should not be based on the phenomena that have not been proved yet by the experimental or theoretical findings. Here I would like to give a remarkable example of a research that will always be remembered in the history of physical sciences. French physicist Sadi Carnot based his work on an inaccurate hypothesis of heat known as Caloric. Despite of the fact he knew that heat is not an ‘imponderable substance’ but is a form of energy like mechanical energy, he based his research on this hypothesis because it was prevalent from the time of Isaac Newton. Fortunately, this did not affect his

work because the results of his reasoning were independent of any hypothesis. Though he himself was not committed to this inaccurate hypothesis but he knew that it was not going to affect his findings in anyway and above of all it was according to the well established fact of that time. Therefore any research should be based on the facts prevalent at that time.

In this little book, instead of demonstrating a complex machine, I have tried to develop a theory independent of any mechanism or a concrete design. The effort is to understand how this perpetual motion can be attained theoretically. I have based my study not on some hypothesis but on a well established principle known as Carnot principle. The result of the reasoning given in this book is that Second Law of thermodynamics and Carnot principle can not go together. They are not consistent.

According to Carnot principle there is not any engine in this universe that is more efficient than Carnot engine working between same temperature difference and same reservoirs. The success of second law of thermodynamics is based on Carnot principle and therefore it seems very absurd to say that they are contradictory. There are many reasons not to believe this when we see around us that every natural phenomenon is taking the universe forward in time. Every natural process has a definite direction and this direction is called the 'arrow of time' and the reason behind this increasing 'chaos' is Carnot principle that suggests that heat is not hundred

percent convertible. But results of the study presented in this treatise say that 'entropy' can be decreased which means heat can be converted completely into any other form of energy in an isolated system and this generalization is the result of contradiction between Carnot principle and second law. To deny this will be to overthrow two hundred years old Carnot principle and to overthrow this principle also means to overthrow the second law. Thus in either cases this law can be said invalid. That is why I am quite confident that this book will not disappoint the experts of mainstream physics.

Nov. 2011 Charanjeet Singh Bansrao

CHAPTER-I

Perpetual Motion:

In the words of Sadi Carnot “The general and philosophic acceptation of the words perpetual motion should include not only a motion susceptible of indefinitely continuing itself after a first impulse received, but the action of an apparatus, of any construction whatever, capable of creating motive power in unlimited quantity, capable of starting from rest all the bodies of nature if they should be found in that condition, of overcoming their inertia; capable, finally, of finding in itself the forces necessary to move the whole universe, to prolong, to accelerate incessantly, its motion. Such would be a veritable creation of motive power.”

From these words it is clear that perpetual motion is not only a motion of a device but this motion should also be capable of providing unlimited motive power without causing any change in its own magnitude. For example the motion of a pendulum isolated from all effects is not a true perpetual motion because we can not extract any motive power from it. The moment we start using its motion for some purpose it will start deteriorating. We know that

friction plays an important role in the deterioration of the motion of a machine. Thus a perpetual motion machine should be capable of compensating all these losses along with the production of some motive power.

The pursuit of perpetual motion no doubt is the pursuit of perpetual happiness. Imagine, you are driving an automobile without bothering that it will ever run out of fuel and this imagination can lead you to the longest journey of your life. You can sail around the world in your boat. You can keep your homes warm during winters and cold enough during summers without paying for it. Man can even change the deserts into glaciers if he is once able to attain the perpetual motion.

The pursuit of perpetual motion dates back to middle ages. Most of the machines for achieving this perpetual motion were designed during this age. All of them are over-unity devices and are generally based on the phenomenon that objects are attracted towards earth i.e. phenomenon of gravity. Magnets were also proposed instead of heavy weights. Machines were generally in the shape of a wheel that was overbalanced or so called by their inventors. The principle is that wheel is never balanced by the weights hanging along its circumference due to which it keeps on rotating because of unbalanced gravitational pull. Same is the principle of magnetic motors that are very popular on internet. But the matter is not that simple because gravitational and

magnetic forces are conservative forces and they can not produce extra work in a closed loop. We can use other laws of mechanics for rejecting such machines but general law is that it is not possible to extract extra work from a conservative force in a closed loop whether it is gravitational, magnetic, electrical or restoring force. As science advanced it became clear that over-unity devices are not possible because of law of conservation of energy. Thus over-unity devices violate the first law of thermodynamics or principle of conservation of energy because they produce energy out of nothing. That is why they are also known as first kind of perpetual motion machines.

It was during second half of 19^{th} century when British professor, John Gamgee came up with totally different idea of perpetual motion which was not against the law of conservation of energy. He proposed a device known as Zeromotor. His idea was to replace the water in a steam engine with ammonia. It is a liquid that boils at -33.5°C. Idea was that the ambient heat can be used to boil the ammonia due to which it will expand and push the piston. Professor Gamgee thought that with expansion ammonia would condense and the liquid can be pumped back to the boiler. But it did not happen because there was not any cold reservoir nearby having a temperature lower than -33.5°C that could be used to condense the gaseous ammonia. Therefore the process proposed by Professor Gamgee is forbidden by second law of

thermodynamics that prohibit the conversion of heat energy into work without dumping any part of it elsewhere.

Thus the perpetual motion machines that take the heat from single reservoir and convert it completely into work are called perpetual motion machines of second kind because they violate second law of thermodynamics.

Entropy:

In day to day life we come to see many phenomena which we know that are heading towards future. For instance when the billiard balls, ordered by a rack on the table, are hit by the shot ball they are scattered. If we make the video of this event and play it backward so that the balls are ordered again then one can easily recognize that the video is being played backward. But if we make the video of only two balls striking against each other and against the borders of the table and then we play it, no one can say for sure if the video is being played forward or backward. Similarly in a gas there are molecules that have kinetic energy and keep on bumping into each other randomly. It is not possible that they may come into order themselves in one corner of the container.

Everything in this universe is made of atoms. Due to thermal agitation these atoms move. In gases these movements are of greater magnitude due to which they freely move like billiard balls. Thus the heat plays an important role in increasing the

disorder. The degree of disorder is known as 'entropy'.

If a mass is resting at some height then we can use its potential energy to compress a spring (assuming a frictionless world) and then this compressed spring can be further used to produce electrical energy or for lifting any other weight. Here we are assuming that all these transformations are without the production of any heat due to friction caused while carrying out those processes no matter whether this production is due to heat caused by the friction of air or due to flow of electric current in metallic wires. All other transformations of energy are complete except the complete transformation of heat energy into any other form of energy.

But why heat can not be completely converted into work? Imagine an ideal heat pump that can pump the heat from one region to other region. Let us put some amount of work into this pump. The increase in the heat energy of the hot region, then, will be equal to the sum of work input and heat taken from cold region. Hence the coefficient of performance of a heat pump is more than hundred percent. Now reverse the process, thus heat flows from hot region to cold region. This time heat pump works as a heat engine. In this way the work is recovered from the engine and the heat taken from the cold region is given back to it and the whole system comes back to initial values. Hence we can say that the heat generated by the work input given

to the pump is completely converted into work when the process is reversible. In simple words it can be said that when work is used to heat up some region and at the same time some cold region is created the process is reversible.

Now let us think of an electric water heater. This heater heats the water by consuming the electricity. But this conversion of electricity into heat is not with the simultaneous creation of some cold region which means no heat is taken from the outside due to which coefficient of performance of an electric heater is hundred percent. If we want to recover the electricity from this heat by fitting some engine to the heater we can not get hundred percent back because some heat has to be dumped to the surrounding. Therefore we can not reverse this process. It is not possible to convert this generated heat into the same amount of electricity. Similarly the heat generated from combustion and other chemical processes, nuclear reactions can not be completely converted into work because this production of heat is without the simultaneous creation of cold region.

We know that friction is inevitable in all actual processes. This friction generates heat and this generation of heat is without creation of cold region. This loss of energy in the form of heat can not be reversed. Hence the amount of energy that can not be used for any purpose keeps on increasing in the universe. This useless energy is responsible for the accumulation of 'entropy' in the universe. Thus the

entropy of the universe always increases. According to this generalization the things in the universe get messier with time. In other words the disorder in the universe keeps on increasing.

The entropy can decrease if somehow molecules of gas get collected by themselves in one corner of the vessel. But according to the principles of probability the chance of occurrence of such an event is almost zero because number of molecules in random motion is very big hence there is unimaginable number of ways in which they can be arranged. Due to large number of molecules second law has statistical certainty. Despite that it has been competing with all other laws of nature that are highly precise for two centuries.

The concept of entropy makes the second law of thermodynamics the most depressing law of nature. It denies the possibility of use of ambient heat for our all purposes. The lost energy resulting in the production of entropy can not be brought back like lost love. This tendency of universe of going from more ordered state to less ordered state is represented by 'arrow of time'.

Carnot principle:

In 1824, French physicist Sadi Carnot published the book "Reflections on the Motive Power of Fire and on Machines Fitted to Develop that Power". In the book, he developed a principle, now known as Carnot Principle. According to this principle an engine

working between two thermal reservoirs at a temperature difference can not be more efficient than the Carnot engine working between the same reservoirs at same temperature difference.

We know that there are many types of heat engines like steam engine, petrol engine, diesel engine, Stirling engine, steam turbines etc. All the engines produce the useful work from the flow of heat and the heat flows from hotter region to colder region. Therefore it is necessary that there should be two reservoirs; one at higher temperature and another at lower temperature. All of these engines have different thermodynamic cycles that limit their efficiency but none of these engines can exceed the limit defined by Carnot cycle. This limit purely depends on the temperature difference between which an engine is operating.

For the development of this principle, Carnot imagined a hypothetical engine operating under ideal conditions like the total absence of friction, perfect isothermal processes and thermal insulation, and infinite time period of operation. Any other engine working under similar conditions and between same thermal reservoirs and temperature difference can not be more efficient than Carnot's engine. Even thermocouples, sound waves, winds, water currents in oceans follow this principle. This principle is the base of second law of thermodynamics because it helps in understanding why we can not extract the work from the heat in thermal equilibrium or why the

entropy of the universe always tends to increase. This can be explained by the following simple demonstration.

Suppose there is an engine E more efficient than Carnot engine C working between two thermal reservoirs, hot reservoir H and cold reservoir R as shown in diagram 1.

Both the engines are of same capacity i.e. they are of same volume and contain equal amount of gas. We will run the engine E in reverse order i.e. it will work as a heat pump.

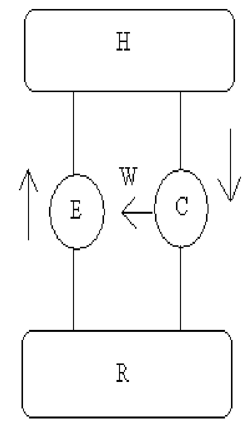


Diagram 1

Carnot engine draws some amount of heat from the hot reservoir and produce some work W out of it and dumps some heat to the cold reservoir. This work W is fed to engine E which uses it to pump heat from reservoir R to reservoir H. Since we assumed that engine E is more efficient than Carnot engine,

therefore heat pumped by it to the hot reservoir will be more than the heat drawn by Carnot engine. As a result of this there will be temperature difference more than it was earlier. With this greater temperature gradient Carnot engine will produce more work than before it did because its efficiency depends on the temperature gradient; greater the temperature difference greater amount of heat is converted into work. We can again feed this work to the engine E. This time it will pump more heat. As a result of this the hot reservoir will get hotter and cold reservoir will get colder in each cycle. If we let this cycle running there will be a time when whole heat from reservoir R will be transferred to reservoir H. But in reality we do not see such phenomenon. We never observed that heat is flowing itself from cold region to hot region. Therefore it is not possible that an engine is more efficient than Carnot engine. No engine can beat Carnot engine.

From the above demonstration no useful power is obtained but it can be shown that both the reservoir will cool down if we try to extract some power assuming that engine E is more efficient than Carnot engine.

Let us restart the cycle. Carnot engine produces some work W by taking some heat from the hot reservoir. This work is fed to engine E and pumps heat from reservoir R to reservoir H but this amount of pumped heat is greater than the amount taken by Carnot engine as discussed earlier. Thus reservoir H

gets hotter and reservoir R gets colder than before i.e. temperature difference has increased. Due to this Carnot engine will produce more work than produced earlier. Let us extract surplus amount of work so that same amount of work W is fed to engine E and we can repeat the cycle. In this way some amount of work is extracted in each cycle. Consequently, both the reservoirs will cool down. But it is forbidden by Carnot principle because no engine can beat Carnot engine when it comes to efficiency.

From Carnot principle we can also conclude that it is not possible to construct an engine which has only one reservoir i.e. an engine that takes heat only from one reservoir and converts it completely into work. Since we have shown that if an engine is more efficient than Carnot engine it will result into cooling down of the reservoirs. Suppose it happens and reservoirs get colder than their surrounding, then we can take ambient heat for heating up the reservoir H and can continue the cycle. Here what happens that the system takes the heat from the surrounding and converts some part of it into work but it does not dump the residual heat to the surrounding. Thus we can say that heat goes from surrounding to the system but does not come out. But it is not possible unless one of the engines is not more efficient.

That is why Carnot principle is the base of second Law of Thermodynamics.

So at this point we can say that if one wants to violate second law he has to prove that Carnot

principle is not valid.

When Carnot published his book the atom was not discovered at that time but it was a very familiar phenomenon that hot substances get cold but hot never gets hotter by itself and it is still a matter of common sense. There should not be any wonder if this does not happen at microscopic level because at macroscopic level all the differences become average. When the things get complex we ask what is the order on average. This is the essence of this principle that, even though the science has advanced so much that we test every theory with advanced mathematical instruments; this principle can not be said invalid.

Due to the strength of the validity of this principle, in the next chapter we shall use this principle for violating the second law of thermodynamics.

CHAPTER II

As we know that our atmosphere is a vast reservoir of thermal energy. From this immense reservoir we may draw the moving force necessary for our purposes; only if, we are able to violate the second law of thermodynamics. If we succeed in extracting this thermal energy from the atmosphere then we can produce impelling power at all times and in all places free of any cost. To develop this power from ambient heat is the objective of second kind of perpetual motion machine. As discussed earlier any device that runs endlessly by violating the second law of thermodynamics is called the perpetuum of second kind. But so far no such machine, device or engine has been developed therefore our interest should not be to know the economical feasibility of investment in such a machine but to know whether it is possible to violate the second law of thermodynamics. It is such a unique law established by great minds that our race can ever produce that has passed every experimental and theoretical test. Moreover this law, despite of its statistical certainty, got as much precision in explaining natural phenomena as other laws of nature have. Entropy is one of its characteristics.

Since second law has statistical certainty, we will adopt a very simple macroscopic approach in order to violate this law.

It is a fact that friction is a cause of heat, no matter how it is produced and for producing friction we need some mechanical work. At the end of the eighteenth century Count Rumford observed that phenomenon in Munich. He noticed that boring of cannon causes heat and the mechanical energy expended in that boring was roughly measured by the amount of heat produced. Later Joule carried out a careful experiment in order to measure the exact amount of heat produced by performing a definite amount of mechanical work. This experiment led to the determination of mechanical equivalent of heat. According to this fact, no matter how the mechanical work is done or how it covers its path, an equal amount of heat is produced. In other words the heat produced is strictly proportional to the work done.

In this way a relation between heat and work was established. This relationship led to the development of thermodynamics.

The transfer of energy between different systems takes place in the form of heat and work. When a gas is compressed in a cylinder by performing work on the piston, it gains the energy, hence its temperature increases. Thus the energy of our muscles is transferred to the gas by work. If we put the gas in contact with hotter substance it gains energy by conduction. This transfer of energy is purely in the

form of heat.

According to the law of conservation of energy the gain of energy of one system should be equal to the loss of energy of another system. This loss or gain of energy by one system results in the change of its internal energy.

Internal energy of a system is the total amount of energy possessed by it. Thermodynamics is not interested in what kind of energies a system possesses but it is only concerned with the change in its internal energy that occurs after a thermodynamic process because all forms of energy rarely take part in a process.

Internal energy is a state function because its value depends only upon the current state of the system. A system can reach a particular state by a lot of ways. Internal energy is independent of these paths taken by the system. We can simply measure the change in it by considering its initial and final values.

At present we should focus on a monatomic ideal gas. This gas will be the subject of our present study.

In a monatomic ideal gas we assume that there are not any repulsive or attractive forces between the particles of the gas. Thus its internal energy constitutes the kinetic energy of the particles only. If the gas goes through some thermodynamic process we can find out the change in its internal energy by considering its initial and final state. Since the

internal energy of the gas is the sum of kinetic energy of its particles and if we know the mass and temperature of the gas, we can calculate the total kinetic energy or internal energy of the gas by the following formula

$$E = 3/2\ nRT$$

Where n is the number of moles; R is universal gas constant and T is the temperature on Kelvin scale.

Thus the only way of knowing the initial and final values of the gas is temperature. Hence the internal energy of an ideal gas depends only upon its temperature. It can be easily explained as this. Let us consider two boxes of different volume filled with the equal amount of an ideal gas at same temperature. Suppose the volume of box A is ten times the volume of box B therefore pressure in the former will be ten times less than the latter. If we calculate the internal energy of both the boxes individually from the values of pressure then algebraically it will be found to be equal. Hence internal energy of an ideal gas depends only upon its temperature

It is very important to define the system whether it is open, closed or isolated especially when it comes to the explanation of violation of second law of thermodynamics.

A gas enclosed in a cylinder with a moveable piston, a cube of ice or a refrigerant in a heat pump can be called system. Thus any part of this objective

world which is the subject of study is a system. The rest of the universe is called surrounding or reservoir. If we imagine an infinitesimally thin line around the system then this is called the boundary. This line can also be physical, for instance, the walls of the cylinder and piston is the physical boundary inside which gas is confined. Similarly we can make an imaginary boundary around the cube of ice. The boundary can distort as the system expands or contracts but our focus should not deviate away from the system which directly means that every unit of energy coming in and going out of the system across its boundaries should be counted.

The systems can be classified according to their interactions with the surrounding or other systems. Thus there are three systems, open, closed and isolated. In an open system both matter and energy can be exchanged across the boundary. In a closed system only energy can be exchanged across the boundary and in an isolated system the exchange of both is prohibited.

Now let us suppose there is a cylinder closed on both ends and there is moveable partition in the middle of the cylinder. Thus cylinder is divided into two sections of equal volume— A and B. Both sections are filled with a monatomic ideal gas at equal temperature and pressure which means amount of gas is equal in both sections. In diagram 1 the cylinder is shown from one side. In this case our subject of study is the gas confined inside the

cylinder in both sections. The walls of the cylinder are boundary and rest of the universe is surrounding. During our course of study we will consider closed and isolated systems only.

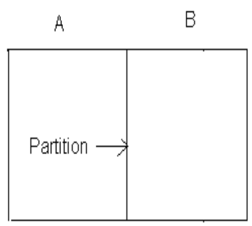


Diagram 1

Let us push the partition towards right (diagram 2). This operation is adiabatic which means there is no interaction of the system with any other system or surrounding across its boundary. As a result of this action, the gas in section B is compressed and gets heated up because the work is done upon it whereas gas in section A expands and cools down because it is performing the work along with the external force applied by us. We will call this external force the impulse because this single push will be responsible for the perpetual motion.

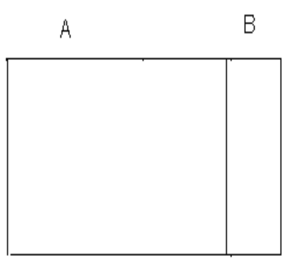


Diagram 2

It can be recognized easily that some heat from the section A is transferred to section B. According to law of conservation of energy this transfer of heat energy can be expressed by the following equation.

$$\Delta U_{\text{section B}} = W_{\text{external force}} + W_{\text{section A}} \qquad (1)$$

Where $\Delta U_{\text{section B}}$ is the change in internal energy of section B, $W_{\text{external force}}$ is the work done by external force (force applied by us) or as said earlier this is the impulse and $W_{\text{section A}}$ is the work done by section A. Thus change in internal energy of section B is the sum of impulse and work done by section A. From equation 1 it can be easily recognized that the transfer of energy is purely by the means of mechanical work. In other words we can say that mode of transportation of energy in this case is the mechanical work.

As the section B is compressed its temperature and pressure rise whereas temperature and pressure of section A fall. But this should not affect the thermal capacity of both the sections because here we have taken a monatomic ideal gas for our present discourse. Hence the energy is purely stored as the kinetic energy of the particles of the gas. Therefore we can suppose that thermal capacity of both the sections is same as it was before the operation.

From equation 1 it is clear that our partition is acting like a compressor of a heat pump. If some

work input is given, it transfers some amount of heat from the section A to section B. Thus a thermal disequilibrium is established.

Now let us fit a Carnot Engine between both the sections as shown in diagram 3.

Since we have created a temperature difference by pushing the partition, we will use this temperature difference for producing work by the means of Carnot Engine. Let us make our system that is our ideal gas, a closed system which means that it can exchange its thermal energy with another system.

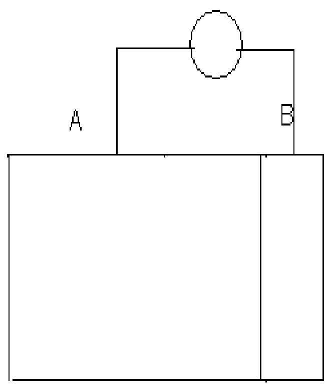


Diagram 3

In this case our second system is the Carnot engine.

Here section B is at higher temperature than section A therefore heat flows from section B to

section A through the Carnot engine due to which it produces some mechanical work and when both the sections establish the thermal equilibrium it stops running. After that we can store that work in any way whether it is the rotational energy of a fly wheel or potential energy of a weight lifted to some height or electrical energy stored in a capacitor. That should not be our focus. Our attention should only be at the amount of work recovered by the Carnot engine.

Now here it is very important to ask a question that can lead us to the violation of second law.

Is the work performed by Carnot engine is equal to the work performed by us in pushing the partition due to which thermal disequilibrium is established between both the sections?

If it is so then we can say that work performed by us has been recovered through Carnot engine and, hence, we succeeded in creating pressure disequilibrium between both the sections without spending any energy.

The question raised above can be answered by Carnot principle. This is a well established principle and is one of the statements of Second Law of Thermodynamics. According to this principle an engine working between two reservoirs having a temperature difference can not be more efficient than any other type of engine working between same reservoirs and temperature difference. In a more generalized form this statement says that no engine can be more efficient than Carnot's engine working

between same reservoirs and temperature difference.

Since we have chosen an ideal gas as our working agent in the cylinder and it has already been discussed that thermal capacity of an ideal gas remains constant i.e. it is not affected by change in pressure and temperature.

In diagram 2 there is temperature difference between both the sections. If the partition is allowed to move then the same amount of work can be obtained from this movement as was performed by us in pushing it towards right. Now we can reconsider the diagram 3 and according to Carnot's Principle we can say that Carnot engine produces same amount of work from the temperature difference of both the sections as we can obtain by allowing the partition to move or the work produced by Carnot engine is as much as was performed by us in pushing the partition.

Suppose Carnot engine is more efficient than the partition i.e. it can pump more heat from one section to another section than the pumped by the partition if same amount of work input is given. Thus we can get more work from Carnot engine than is done by us in pushing the partition which means that engine is consuming more heat from the section than is pumped by the partition. But it can not be true because in that case the sections will get colder without dumping any heat elsewhere.

Now suppose partition is more efficient than Carnot engine i.e. it can pump more heat than

Carnot engine can. Let us heat up one section by supplying heat from the outside. Now allow the heat to flow from this section to another section through the Carnot engine. As a result of this some work will be performed by the engine till the thermal equilibrium. Now we can use this work in pushing the partition. Since the partition is more efficient than the Carnot engine it will supply more heat from one section to another than was supplied from outside. Use this temperature difference for producing work by Carnot engine but this time work done by it will be more. We can bring the partition in the middle by bringing both sections in contact with the surrounding due to which both sections will come to their initial volumes without changing their temperature and net amount of work will be done by the sections. Then we can repeat the process by using the work performed by Carnot engine. This time the heat pumped by the partition will be even more. Thus in each cycle the entropy of the universe will decrease. So partition can not be more efficient than Carnot engine.

Hence it is proved that we can recover the work performed by us in pushing the partition towards right if we fit a Carnot engine and allow the heat to flow from section B to section A through it without allowing the partition move towards left.

Let us reconsider the equation 1. The change in internal energy is the sum of work performed by external force applied by us and work performed by

the pressure of gas in section A. The work performed by us has been recovered by Carnot engine. The work performed by section A has been recovered in the form of heat energy which is dumped by the engine into it. At the end of the process both the sections retain the initial thermal equilibrium but with a change in their volumes. Thus pressure disequilibrium is established between the sections.

Now let us remove the Carnot engine and put the cylinder in thermal communication with the surrounding i.e. it can exchange the heat with the surrounding. Here we suppose that surrounding and cylinder are at the same temperature. Let us allow the partition to move. The pressure of gas of section B pushes the partition against the pressure of section A. As the section B expands its temperature decreases but it receives the heat from the surrounding at the same time. On the other hand the section A is compressed due to which its temperature increases but instantly it rejects the heat to the surrounding (diagram 4). Hence process is isothermal; the temperature of the cylinder (both the sections) remains constant.

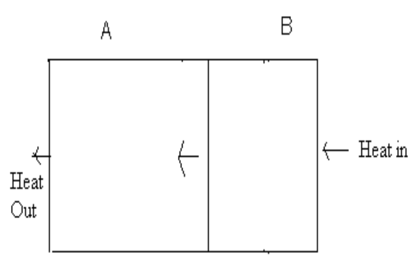


Diagram 4

The heat rejected by section A is less than the heat received by section B. This is due to the fact that pressure of section B is more due to which average number of collisions per unit of time of the molecules of gas against the partition are more than the average number of collision on the side of section A. In another way it can be said that expansion in the volume of section B is greater than the compression in the volume of section A hence section B absorbs more heat than the section A rejects in order to maintain their temperature. As a result of this a net amount of work is done by section B. Hence there is net consumption of thermal energy. In other words a net amount of heat enters the cylinder.

Since there is consumption of some heat of the surrounding, its internal energy decreases; due to which the temperature also decreases but this change is negligible because of infinite thermal capacity of the surrounding. The surrounding is a part of universe and this universe is an ultimate closed system. So at this point we are led to make this generalization—

“The Entropy of a closed system can be decreased.”

Denying this statement means disobeying the Carnot principle and disobeying the Carnot principle means accepting this statement. Thus the statement “entropy of a closed system always tends to maximum” is invalid whether we obey or disobey Carnot principle.

CHAPTER III

In previous chapter we learnt that perpetual motion of second kind is possible. But before thinking of a machine that can achieve this perpetual motion for us, we are required to think of a thermodynamic cycle on the basis of which all the future perpetual motion machines can be constructed.

Since for the development of our concept we have made the use of Carnot engine, we have to consider Carnot cycle.

Actually what happens in our demonstration explained in the previous chapter is that Carnot engine receives the heat from hotter section, performs some work and rejects the waste heat to another section. Thus a complete Carnot cycle runs outside the cylinder. In a Carnot cycle there are two isothermal processes and two adiabatic processes. Since we have considered finite reservoirs therefore instead of isothermal processes there will be two diabatic and two adiabatic processes in our demonstration.

In diagram 1, section B is considered as hot reservoir. Let its temperature be T1. This

temperature of the section is achieved by compressing it. Thus before compression its temperature is T0.

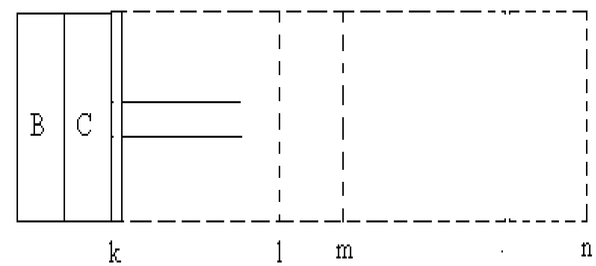


Diagram 1

A Carnot engine C is in contact with it. It contains equal amount of gas at same temperature as section B possesses. Thus both are in thermal equilibrium at temperature T1. The gas of Carnot engine expands by receiving the heat from section B. This expansion goes till point ‘m’. At this point the temperature of the gas of section B and Carnot engine falls to T0.

Let us remove section B. The piston of Carnot engine moves till point ‘n’. At this point the temperature of the gas falls to T2.

Now let us put the Carnot engine in contact with section A as shown in diagram 2. The section A is at temperature T2.

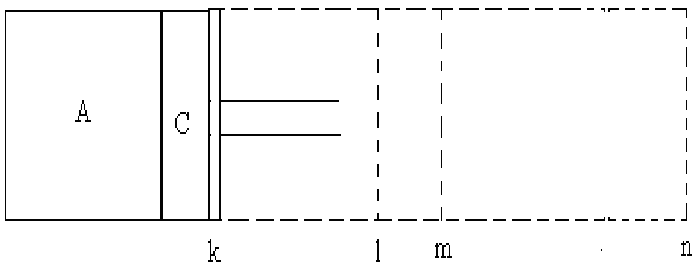


Diagram 2

The piston returns from position ‘n’ and compresses the gas diabatically till point ‘l’. At this point the temperature of gas of section A and Carnot engine reaches T0.

Remove the section A. The piston compresses the gas till point ‘k’ and attains initial position. The temperature of the gas reaches initial value T1.

It is clear that distance ‘km’ is less than the distance ‘ln’. Hence Carnot engine yields some motive power. According to our theory this motive power should be equal to the energy consumed in establishing the temperature difference between the section B and section A by compressing the former along with the assistance of the latter.

This Carnot cycle can be obtained if we employ the section B as the Carnot engine. This can be explained as below.

Consider diagram 3. In diagram there is a cylinder in which two moveable pistons A and B are

placed. The piston A is positioned in such a way that displacement ‘m-o’ is as much as displacement ‘n-p’. The piston B is so fitted that it is as much above the bottom as much the piston A is above it. Thus it divides the lower section into two equal parts. Similarly, the point ‘p’ is in middle of displacement ‘o-q’. The lower section is filled with an ideal gas at temperature T_0 and pressure P_0. The amount of gas is equal below and above piston B. The cylinder is closed on both ends.

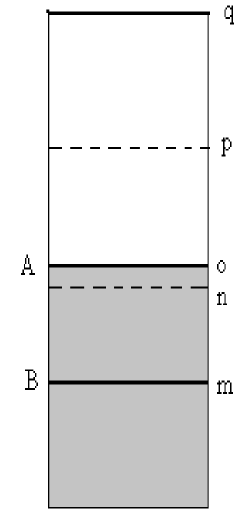


Diagram 3

(1) Push the piston B upwards to the position ‘n’. The piston A remains locked in its place (diagram 4). As a result of this the gas above piston B is compressed due to which its temperature is raised to T_1 and pressure is raised to P_1 and the gas below it expands therefore its temperature falls to T_2 and pressure falls to P_2. This operation is same as demonstrated in diagram 2 in the previous chapter.

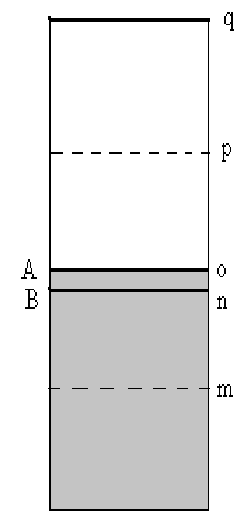


Diagram 4

(2) Unlock the piston A and lock down the piston B. Here we suppose that the piston A is externally connected to some resistance like a flywheel. The compressed gas pushes the piston upwards to the point ‘p’ (diagram 5). As a result of this its temperature should fall from T_1 to T_0 and pressure should fall from P_1 to P_0 because the distance ‘n-m’ is equal to distance ‘o-p’.

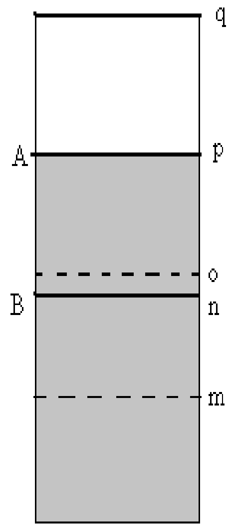


Diagram 5

(3) Keep the piston moving up to the position ‘q’ as shown in diagram 6. As a result of this further expansion the temperature should fall from T_0 to T_2 and pressure should fall from P_0 to P_2.

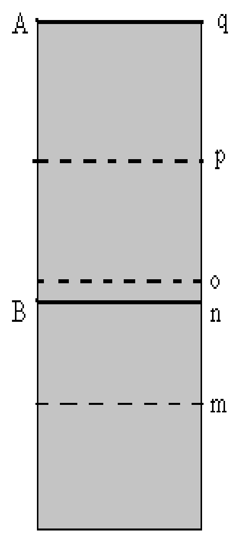


Diagram 6

(4) The piston A moves downwards up to the position ‘p’; the partition B remains locked at position ‘n’ as shown in diagram 7 but this time we will allow the heat to flow through piston B i.e. the piston B allows the thermal communication between the gas below it and gas above it. With this compression the temperature and pressure of the gas will rise but not up to T_0 and P_0 but less than that because of the exchange of heat. Suppose these values are T_3 and P_3 respectively. Meanwhile the temperature of the gas below the piston B will also be T_3 but pressure will be less than P_3 because it is occupying greater volume.

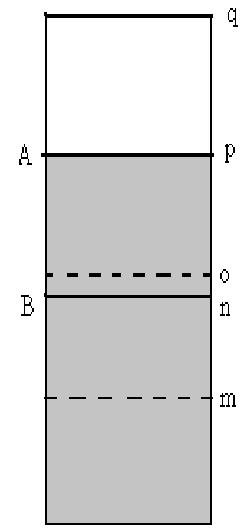


Diagram 7

(5) Piston A keeps on moving till the position ‘o’ as shown in diagram 8. The temperature of the gas below and above piston B rises to T_0 and pressure of the above gas rises to P_4 which is directly

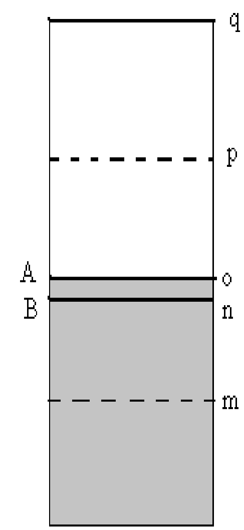


Diagram 8

proportional to its volume. Let us reconsider diagram 5. In the diagram piston A is at position ‘p’. At this position the temperature and pressure of the gas confined between both pistons is T_0 and P_0 respectively. In diagram 8 the same gas is again at temperature T_0 but confined inside much lesser volume. Suppose height n-p is eight times the height n-o, then the pressure P_4 of the gas trapped between two pistons will be eight times the pressure P_0 when the piston is at position ‘p’ in diagram 5 this is due to the fact that temperature of the gas is same in both cases.

(6) Put the cylinder in thermal communication with the surrounding. Here we suppose that surrounding is also at temperature T_0. The piston A is locked but the piston B is allowed to move. The compressed gas expands isothermally pushing the piston B downwards against the pressure of the gas below it. As gas below is compressed it rejects the heat to the surrounding immediately. Similarly expanding gas receives the heat immediately. The change in volume of expanding gas is eight times the change in the volume of the gas being compressed. Thus expanding gas receives more heat than the heat rejected by the gas being compressed; hence a net amount of work is done by the expanding gas if we connect the piston B to some load externally. The system comes to the initial state as the piston reaches at point ‘m’ as shown in diagram 3.

The above series of operations can be summarized as below:

1. Compress the gas adiabatically by pushing the piston B upwards. It raises the temperature of the gas above it and reduces the temperature of the gas below it.
2. Lock the piston B and unlock piston A; the gas expands adiabatically pushing the piston upwards against the external resistance.
3. The piston continues moving upwards and reaches the top end of the cylinder. The temperature and pressure of the gas becomes equal to the temperature and pressure of the gas below the piston B.
4. Now the external resistance performs the work on the piston A due to which it moves downwards. The gas is compressed diabatically i.e. there is an exchange of heat between gas below and above the piston B.
5. The piston A reaches at its initial position. With this the gas above and below piston B attains its initial temperature which was before the beginning of the cycle. There is no temperature difference but the pressure of the gas above piston B is much greater than the pressure of the gas below it. Since displacement ‘m-o’ is equal to displacement ‘n-p’ and ‘n-p’ is eight times ‘n-o’ therefore ‘m-o’ is eight times ‘o-n’. Total displacement from

piston A to the bottom of the cylinder is the double of 'm-o' therefore it is sixteen times the 'o-n'. Thus pressure of the gas between the two pistons is sixteen times the pressure of the gas below the piston B.

6. In the last step put the cylinder in thermal communication with the surrounding. Here we suppose that surrounding is also at temperature T_0. The piston A is locked but the piston B is allowed to move. The compressed gas expands isothermally pushing the piston B downwards against the pressure of the gas below it. As gas below is compressed it is heated up but rejects the heat to the surrounding immediately. Similarly expanding gas receives the heat immediately. The system comes to the initial state as shown in diagram 3.

We can see that the impulse given by us in the first step is recovered in next four steps while the motive power is obtained in the last step. In the last step the whole system attains its initial state. The impulse recovered by us in 2^{nd}, 3^{rd}, 4^{th} and 5^{th} step can be used to restart the cycle. In this way we can run this machine as long as we wish. We can call this machine "Perpetual Engine" also. Other engines use heat energy obtained by burning of some sort of fuel but this engine uses the ambient heat of the atmosphere.

Let us see the above series of operations on a pressure-volume diagram.

In diagram 9, pressure is shown on vertical axis and volume is shown on horizontal axis.

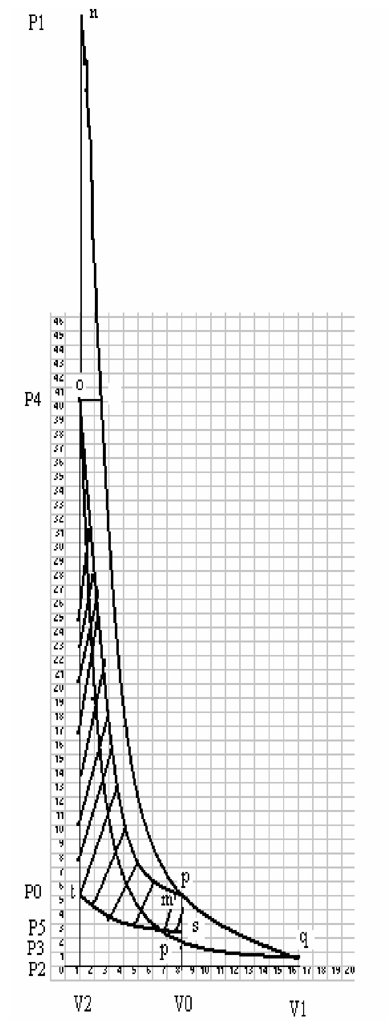


Diagram 9

Here we will consider the part of the gas that is above the piston B. In the first step the gas is compressed adiabatically. This operation is shown by the curve 'pn' in the above diagram. The pressure rises to P_1.The volume is reduced to V_2.

In the second step the gas is allowed to expand adiabatically till the position 'p'. This operation follows the same curve 'np' but in the reverse direction. Thus pressure is reduced to P_0 which is 5 atmospheres and volume increases to V_0.

In the third step the gas is further allowed to expand adiabatically. The same curve continues from 'p' to 'q'. The pressure falls to P_2 and volume increases to V_1.

In the fourth step the gas is compressed diabatically up to position 'q'. Due to the exchange of heat the compression doesn't follow the same curve in reverse direction but follows the lower curve 'qp'. The pressure increases to P_3 and volume reduces to V_0.

In fifth step the gas is continuously compressed diabatically and this compression follows the curve 'po'. At point 'o' the pressure is P_4 and volume is V_2. It is clear from the figure that pressure P_4 is eight times greater than the pressure P_0 because volume V_2 is eight times less than volume V_0. Hence the pressure P_4 is 40 atmospheres. The area 'npqpon' is the recovered work or impulse which was given by us in compressing the gas in very first step.

In the sixth step the gas expands isothermally by receiving the heat from the surrounding and pushes the piston B downwards. This expansion follows the curve 'om'. At point 'm' the pressure is again P_0.

Now we will find out the useful work produced by the engine. Let us reconsider the diagram 6. In the diagram the gas above the piston B is at the same temperature T_0 as is the gas below it but it is confined inside less volume. In the pressure-volume (P-V) diagram this volume is V_2. In diagram 6 this volume is sixteen times less than the volume below the piston B and in P-V diagram this volume is V_1.Hence the pressure P5 of the gas below will be sixteen times less which should be 2.5 atmospheres because the pressure of the gas above is 40 atmospheres. When the gas above expands isothermally it expands against the pressure of the gas below and in the end both settle at volume V_0 and pressure P_0. Therefore the pressure of both the sections of gas settles at 5 atmospheres. Here we can say that the volume of the gas below the piston B reduces from V_1 to V_0 and volume of the gas above increases from V_2 to V_0. The distance $V_1 - V_0$ is equal to distance $V_0 - V_2$. When the pressure of the gas below piston B increases from 2.5 atmospheres to 5 atmospheres its volume is reduced from V_1 to V_0 or we can also say that its volume is reduced from V_0 to V_2 because the distance $V_1 - V_0$ is equal to distance $V_0 - V_2$. Therefore this compression can be shown by curve 's-t' on P-V diagram. So the net work output of

the expanding gas is area under the curve 'o-m' minus the area under curve 's-t' or the area 'omst' (high lightened by the dark lines). This is the useful work produced by the engine and this work depends upon the difference between the pressure P4 and P5. More will be this difference more will be the work output of the engine.

This thermodynamic cycle is hypothetical because it has been carried out under ideal conditions. Let us see what conclusions we can draw from this hypothetical thermodynamic cycle.

For creating more pressure difference the gas above the piston B has to be compressed adiabatically to much less volume in the first step of the cycle. Thus the compression ratio should be very high. Further this compression should be along with the expansion of the gas below piston B so that there is significant decline in the temperature of expanding gas. In P-V diagram the adiabatic curve 'qn' is steeper than the isothermal curves 'po' and 'st' which means that work done in first step is much greater than the motive power received in the last step. Suppose theoretically motive power is 20 percent of the impulse. Since there are many losses in real life processes which can not be avoided, we can not recover the 100 percent of the impulse. Suppose this recovery is 70 percent only and the practical value of motive power is 13 percent of the impulse. This means that we can not compensate the 30 percent loss of impulse from the motive power generated at

the end of the cycle. Thus at the end of the cycle we have 83 (70+13) percent of power of the impulse and extra 17 percent has to be given from the outside. But this is not the characteristic of perpetual motion. The point of this discussion is that in this case the motive power should be above 30 percent of the impulse if we want the real perpetual engine capable of compensating all the friction and heat transfer losses. The heat transfer losses are of major concern.

In above series of operations we can see that the heat transfer between both the sections and between the sections and surrounding are via conduction only. That is to say that we can not allow the gas to flow from one section to another section for the transfer of heat because it will ruin the whole theory. I do not see any method by which the heat can be exchanged across the boundaries at very high rate. We are left with conduction only. For this reason we will have to face the following challenges when it comes to real life application of our theory of perpetual motion.

1. For more output from the engine we will have to run it at high RPM (revolutions per minute) due to which exchange of heat between the sections will not be significant and this exchange will be even poorer with the surrounding.
2. The giant heat exchangers will be required and how will they be fitted between the sections is another problem unless it is not

clear how the two pistons will be assembled.

3. It is very difficult to achieve the locking and unlocking of the pistons when the engine runs at very high RPM.
4. If we run the engine at very low RPM so that there is significant heat exchange then there will be loss of heat to the surrounding during adiabatic and diabatic compression because of imperfect thermal insulation. But as discussed earlier we can not afford such losses in practical.

At this point it is appropriate to consider another real life thermodynamic process. Here the thermodynamic cycle of perpetual motion has been explained by considering two sections; thus temperature difference is created in local region. Now let us see what happens if one of the sections is vast like atmosphere. It can be explained more conveniently by considering “compressed air energy storage system”. It is a way to store energy generated at one time for use at another time. In this system air is filled in a vessel by a pump. Most of the compressed air storage systems use isothermal process but here we suppose that the air is filled adiabatically. As a result of this the vessel gets heated up and its pressure also increases tremendously. But there is negligible change in the temperature and pressure of atmosphere because the

air is taken from atmosphere. According to our theory we can fit an engine between the vessel and atmosphere and recover the work preformed by our pump in order to fill the vessel. According to our theory this is possible but practically this is impossible. We can not obtain 100% work of the pump. This can be clearer from the following demonstration.

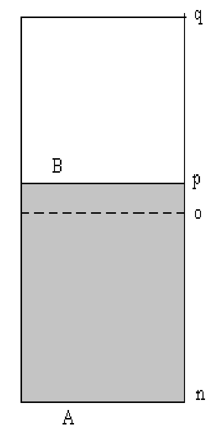


Diagram 10

Let us consider diagram 10. In the diagram there is cylinder having two moveable pistons A and B. The height ‘n-p’ is as much as height ‘o-q’; therefore the displacement ‘n-o’ is also as much as displacement ‘p-q’. A monatomic ideal gas is confined between both the pistons at pressure P0. The top of the cylinder is closed hence there is vacuum above piston B whereas piston A faces the surrounding but it can not go below point ‘n’.

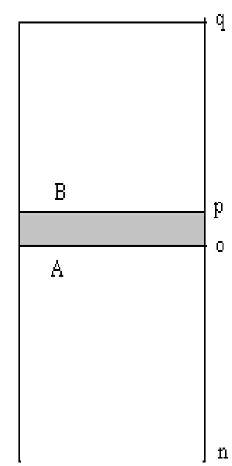
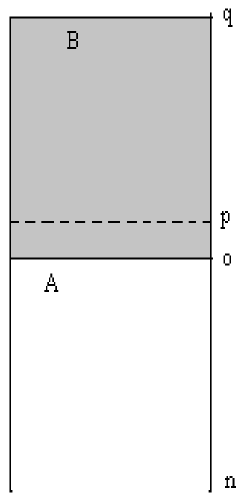


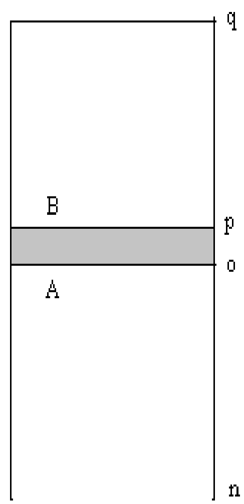
Diagram 11

(1) Push the piston A upwards till point ‘o’ as shown in diagram 11. The gas confined between both pistons gets compressed adiabatically and is heated up. Consequently its pressure rises to P1. On the other hand the gas of the surrounding expands. Here we suppose that the thermal capacity of the surrounding is infinite due to which change in its temperature and pressure is zero.



Diagrat 12

(2) Lock the piston A and unlock the piston B. Here we suppose that the piston B is connected to some external resistance like fly wheel. As the piston B is unlocked the compressed gas expands up to point ‘q’; pushing the piston B against the external resistance (shown in diagram 12). The pressure of the gas falls to pressure P0 because the height ‘n-o’ is as much as height ‘o-p’. Since there is negligible change in the temperature of the gas of the surrounding we can say that the confined gas is again in thermal equilibrium with the surrounding.



Diagrat 13

(3) The piston B starts moving downwards as a result of the action of fly wheel. The piston A is kept locked at its position but this time the heat is allowed to flow across the piston A i.e. the compression of the confined gas is isothermal. The gas is compressed up to point ‘p’ (shown in diagram 13). The pressure of the gas rises to P2 but the temperature remains constant which is equal to the temperature of the surrounding.

(4) The piston A is unlocked and piston B is locked. The cylinder is put in thermal communication with the surrounding. The confined gas expands isothermally pushing the piston A against the pressure of the surrounding and some resistance connected to piston externally as shown in diagram 14.

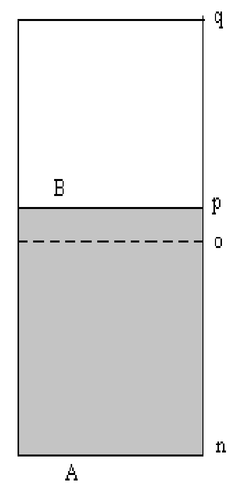


Diagram 14

Now let us discuss this cycle in the light of our theory of perpetual motion. In the first step we compressed the gas adiabatically. The pressure of surrounding gas helped us in compressing the gas due to which its temperature and pressure falls. Since surrounding is infinite, the change in its temperature and pressure is zero but according to our theory we can not ignore that infinitesimally

small change. In the third step, when the gas is compressed isothermally then the heat lost by surrounding is given back to it and work done by us in first step is recovered. In the last step the gas expands isothermally. Thus useful work is produced in this step. The gas is again in its initial state. Theoretically this cycle is able to produce motive power but practically this doesn't seem to be working. It can be clear from the following P-V diagram. In diagram 15, the first step follows the curve 'n-o' when the gas is compressed adiabatically. The second step follows the same curve in reverse direction i.e. from 'o' to 'n'. In this step the gas expands adiabatically. The third step follows the curve 'q-p'. In this step the gas is compressed isothermally. In the fourth step the gas expands isothermally and follows the same curve 'q-p' but in reverse direction i.e. from 'p' to 'q'. The area under this curve is the work done by the expanding gas. The gas expands against the pressure of the surrounding but we assume that surrounding is infinite therefore its pressure remains constant.

Thus work done upon surrounding is area under 'n-r'. Therefore the useful work produced by the system is area 'pqr' whereas area 'onp' represents the recovered work which was performed on the gas in the first step.

Here we can easily recognize that there is no need of first two steps when we are compressing and expanding the gas isothermally in next two steps.

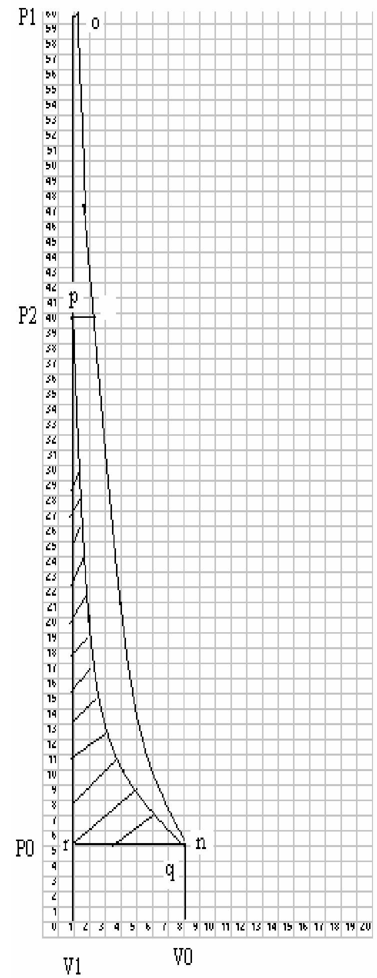


Diagram 15

There seems no need of first two adiabatic processes. It is quite obvious that work done in compressing a gas adiabatically is more than compressing it isothermally.

But if we follow the last two steps then there is no use of that. The work done by the external resistance in compressing the gas and work done by the gas on it is equal and follow the same curve 'p-q'.

But this is not a perpetual motion. We are not getting any useful power from the system because last two steps represent a perfect reversible process. Theoretically we can achieve the perpetual motion if we follow all the four steps but practically the problem lies in the infinite size of the surrounding because theoretically we assume that there is instantaneous thermal communication between the system and surrounding and any change in their values is communicated instantaneously. But in reality due to infinite size of the surrounding as compared to the system this communication is not instantaneous hence we have to suppose that the pressure and temperature of the surrounding remain constant.

From the above discussion we can draw the following conclusions:

There should be simultaneous creation of hot and cold regions. In the above cases when gas confined between the pistons is compressed adiabatically another region expands and cools down automatically.

Secondly, both the regions should be of very small sizes. This will result in considerable changes in the temperature of both the regions.

Thirdly, the heat transfer should be via conduction only. We can not allow the gas to flow across the boundaries for the transfer of heat.

First and third conditions should be the leading characteristics of a hypothetical cycle if any is developed and all of these three conditions should be fulfilled by any practical perpetual motion machine of second kind.

From these three conditions it seems quite difficult to construct an engine that can give the work output equal to the heat engines presently running the electric generators and automobiles. It will be a great challenge to invent the perpetual engine of same size and power but it is certain that perpetual motion of second kind is possible. It can not be said third type of impossibility.